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ORIGINAL ARTICLE

Scabies in French Guiana: Quantitative and qualitative factors associated with therapeutic failure

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Abstract

Background: Strategies for the control of scabies should be adapted to local settings. Traditional communities in French Guiana have non-Western conceptions of disease and health.

Objectives: The objectives for this study were to explore knowledge, attitudes and practices to identify potential factors associated with the failure of scabies treatment in these communities.

Methods: Patients with a clinical diagnosis of scabies, seen at either the Cayenne Hospital or one of 13 health centres between 01 April 2021 and 31 August 2021, were included as participants, and were seen again after 6 weeks to check for persistence of lesions. Factors associated with treatment failure were looked for both at inclusion and at 6 weeks. Semi-structured interviews were conducted with a diversified subsample of participants.

Results: In total, 164 participants were included in the quantitative component, and 21 were interviewed for the qualitative component. Declaring that the second treatment dose had been taken was associated with therapeutic success. Western treatments were not always affordable. Better adherence was observed with topical treatments than with oral ivermectin, whereas permethrin monotherapy was associated with failure. Scabies-associated stigma was high among Amerindians and Haitians but absent in Ndjuka Maroons. Participants reported environmental disinfection as being very complex.

Conclusions: The treatment of scabies in traditional Guianan communities may vary depending on local perceptions of galenic formulations, disease-associated stigma and differences in access to health care. These factors should be taken into account when devising strategies for the control of scabies aimed at traditional communities living in remote areas, and migrant populations.

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INTRODUCTION

Scabies, a common parasitic skin disease caused by the *Sarcoptes scabiei* mite, causes primary itchy lesions and secondary complications such as impetigo, necrotizing soft-tissue infection, rheumatic heart disease, rheumatic fever and glomerulonephritis.[1] In 2017, the World Health Organization (WHO) added scabies to the list of neglected tropical diseases.[2] Risk factors for scabies in tropical areas include poverty, barriers to health care access, lack of cleaning facilities for clothes and fomites, overcrowding and a low level of education.[3,4] There are also risk factors associated with the local culture, such as interference with adherence to treatment, as described in African and Oceanic populations.[5–7] Since a high prevalence of scabies is reported in various autochthonous populations around the world, such as Aboriginal Australians, some communities in the Pacific region such as Fiji and the Solomon Islands,[8–10] and in South American countries such as Colombia,[11] the optimal management strategies should be adapted for each particular region and supported by specific local data.[12]

There are a number of specific issues affecting the control of scabies in the overseas territory of French Guiana. The territory is characterized by a high incidence of poverty and differing representations of health and disease.[13] Most of French Guiana (95%) is covered by dense equatorial forest. The autochthonous populations (Amerindians and Maroons—descendants of fugitive slaves) mostly live in remote settlements along the Maroni and Oyapock rivers, where they retain their traditional ways of life. They are exposed to a high number of infectious skin diseases.[14,15] Most teenagers benefit from secondary education, though about a third of them drop out of school and practice hunting-gathering and agriculture with their parents. Marriage usually happens around the age of 18.[16] Migrants (mainly from Haiti), often living in slums in the coastal region, are another disadvantaged community. Apart from resource-related issues, religious beliefs, traditional healers and natural remedies still play an important social and psychological role in these communities.[17–19] We hypothesized that these contextual differences could impact the control of scabies and decided on a combined quantitative–qualitative approach, which seemed best suited to determine the causes of treatment failure and provide context-sensitive opportunities to improve control strategies.

The main objective of the quantitative-qualitative study was to identify factors associated with the failure of scabies treatment in French Guiana. A secondary objective was to describe the scabies-related knowledge, attitudes and practices of patients from three different local cultures (Amerindian, Maroon, and Haitian) and their potential links with treatment failure. Lastly, the minimum prevalence of scabies in small autochthonous settlements was estimated.

MATERIALS AND METHODS

A prospective observational study was conducted between April 2021 and August 2021 in 11 remote health centres in French Guiana, 2 migrant health centres and the Cayenne (capital city) hospital. A map of the study sites and an anthropological description of the populations they serve is available in the Data S1. Most of the remote health centres are only accessible by boat, plane or helicopter.

Prevalence of scabies

An active household screening was performed and a minimum prevalence estimated in five small study sites (Trois-Palétuviers, Awala-Yalimapo, Camopi, Talhuen, Trois-Sauts) (Figure 1; Data S1), using the number of cases detected as the numerator, and the total population of the village as the denominator (according to the French *Institut National de la Statistique et des Etudes Economiques*).[20] A systematic house-to-house survey was performed with local health workers as guides. Households were screened in a linear (Awala-Yalimapo, Camopi, Trois-Sauts) or clockwise (Talhuen, Trois-Palétuviers) order according to the geographic pattern of each settlement. Households were entered and people examined when there was a notion of pruritus for at least one person. Household size was determined according to people's statements: people who lived there regularly were deemed household members. All identified patients were part of the quantitative analysis and were treated in the remote health centres.

Some patients with scabies may have been missed in larger settlements, so no minimum prevalence was estimated for these sites.

Quantitative study

Data collection

Patients were included if they met the *International Alliance for the Control of Scabies* (IACS) standard criteria for clinical scabies (Category B),[21] and agreed to return for a follow-up visit at 6 weeks (W6). Patients were systematically examined for burrows and/or genital lesions. There was no exclusion on the grounds of age. On inclusion, patients were seen either by the principal investigator or co-investigators from the health centres who had received specific training on diagnosing scabies. At W6, all the patients were seen by the principal investigator (PI) for their outpatient follow-up. The routine treatment protocols of the individual health centres were not changed. We used the standard of care of scabies treatment, either oral ivermectin (200 µg/kg) or permethrin cream (5%) or benzyl benzoate lotion (10%) or a combination of ivermectin plus permethrin or benzyl benzoate, administered at Day 1 and repeated at Day 8–15. Oral ivermectin was not used in pregnant women and permethrin cream was not used under 2 months of age. The choice of a monotherapy or a combination was left to the clinician's discretion. Asymptomatic household members were systematically prescribed oral ivermectin (200 µg/kg).

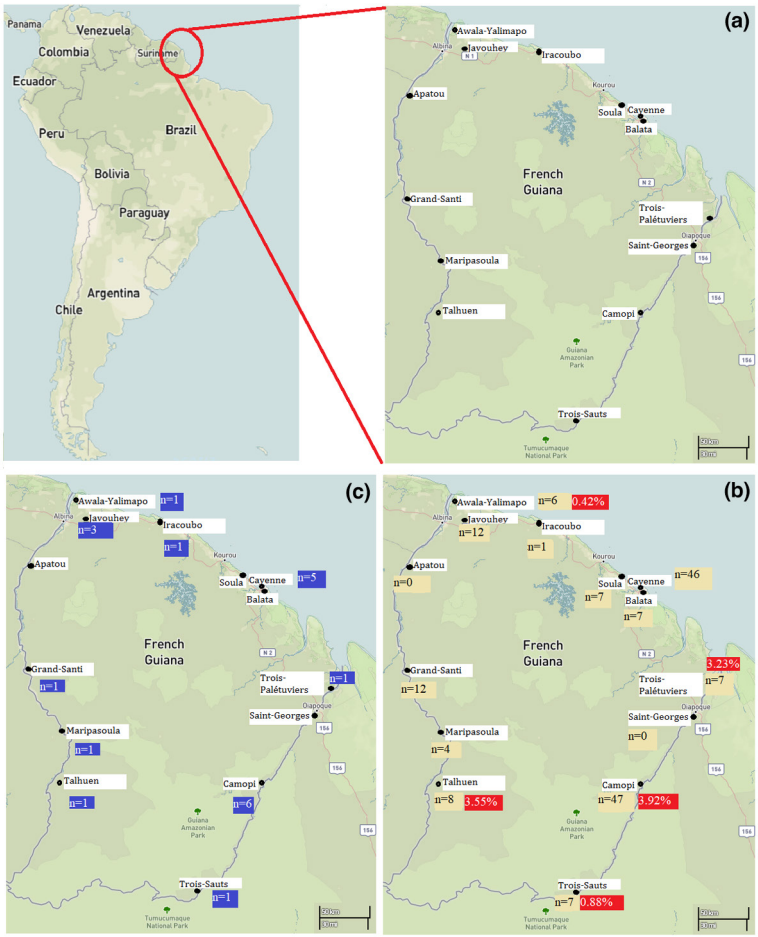

FIGURE 1 Study sites of the GUYAGALE study, 2021; (a) location of French Guiana in South America, and presentation of the 14 study sites (white boxes); (b) number of patients included in the quantitative component for each study site (yellow boxes) and local minimum prevalences of scabies (red boxes); (c) number of participants included in the qualitative component for each study site (blue boxes).

The primary outcome of the quantitative study was treatment failure, defined as the persistence of clinical lesions at W6 (papules, nodules, vesicles or burrows). Treatment success was defined as the complete absence of lesions at W6. Data were collected for each patient using two standardized questionnaires, including:

- At the time of diagnosis and inclusion (D1): identification and general data, clinical signs, care-seeking before consultation, type of housing and cleaning facilities at home, knowledge of the disease, number of people under the same roof, socio-economic variables for the patient and head of family; presence of impetigo
- At the W6 follow-up visit: knowledge of the disease, treatment used, compliance and observance, means of fomite (clothes, bed or hammock) disinfection, treatment failure (primary endpoint) and persistence of impetigo.

European guidelines recommend a new visit 2 weeks after completion of treatment,[22] while, when studying factors associated with therapeutic failure in mainland France, Aussy et al used a follow-up time of 3 months.[23] In our study, an early second visit could have overestimated the proportion of failure, while a longer one could have left time for reinfestation and the risk of lost to follow-up. A 6-week period was deemed as the best compromise. It also represented the easiest option to fit in the expected duration of the study and its associated logistical constraints. The adherence to the second dose of treatment was determined according to the participants' oral declarations.

Data analysis

The clinical, knowledge and socio-demographic variables collected at inclusion and W6 were described in terms of mean, range, median and interquartile range for quantitative variables, and in terms of frequency and proportion for qualitative variables. The main socio-economic variables were also analysed and compared between the different communities. Associations between the baseline characteristics (D1) and the primary outcome evaluated at W6 were explored. Considering the study statistical power

in an estimated source population of 150 participants (75 per group, unmatched), using an alpha risk of 5% and a beta risk of 20%, we expected to detect an odds ratios of 3 for a 0.2 probability of exposure among controls (therapeutic success). In the univariable analysis, Pearson's chi-squared test (or Fisher's test if less than five occurrences) was used for category variables. Variables with $p < 0.2$ in the univariable analysis were included in a descending unconditional stepwise multivariable logistic model. Crude and adjusted odds ratios and their 95% CIs were estimated for each explanatory variable. p values <0.05 for the Wald test in the final multivariable model were considered significant. Stata® software (Statacorps, College Station, TX, USA) was used for the statistical analyses.

Qualitative study

Data collection

Semi-structured interviews were conducted on a convenience subsample of patients already participating in the quantitative component. The sample included participants who differed in terms of gender, age and origin (Amerindian, Maroon, and Haitian). The age groups were 18–24, 25–49 (the largest group in French Guiana)[20] and 50 and above. Children under 18 were excluded from the qualitative study. Participants were also selected from a wide range of positions and roles within the different communities, from highly educated community chieftains or leaders to hunter-gatherers and housewives. The interview cue sheet was designed by the PI in consultation with an anthropologist specializing in the autochthonous cultures of French Guiana. The interviews were conducted in a quiet room at the local health centre, in the PI's office at the Cayenne Hospital Dermatology Department, or during at-home consultations in some villages. The interviews were recorded on mobile phones with the participant's consent, or transcribed by hand in real time. All interviews were conducted in French.

Data analysis

All interviews were manually transcribed to a text file immediately on completion. The data were then analysed using thematic analysis in which themes were identified, key-worded and linked together. A deductive approach[24] was used, based on preconceived assumptions about particular themes (e.g. preference among Amerindians for topical treatments), while a highly inductive approach was used for themes on which no data were available (e.g. attribution of a magical cause). Qualitative data were cross-interpreted by the PI and a specialized anthropologist. Validation was sought from community members, including community leaders and community health workers (CHW). Categories and sub-categories of answers were identified when data saturation was reached, that is, when the same answers and themes occurred repeatedly in the course of the interviews.[24]

Ethics statement

This study was authorized under the title GUYAGALE by an Ethical Review Board (*Comité de Protection des Personnes*, CHU de Grenoble, CS 10217, 38043 Grenoble Cedex 9), with the ID RCB identification number 2020-A02634-35. All the participants gave oral consent to be included in the study; in the case of minors, consent was given by the parents. The patients in this manuscript have given written informed consent to publication of their case details.

RESULTS

Quantitative study

Data at inclusion

Between 1 April and 31 August 2021, a total of 164 patients were included in the quantitative component, and evaluated at least at D1 (Table 1). The mean age was 16.8 years (range 0.5–83), and the median age 13 years [IQR 3–31]. At W6, 93 participants (56.7%) were seen again, and 71 (43.3%) were lost to follow-up. The number of participants included in each study site is shown in Figure 1. The characteristics of the 164 participants are detailed in Table 1.

Concerning clinical presentations, we did not report any patient with more than a few dozen lesions, nor any severe or crusted scabies.

The minimum prevalence of scabies was lower in the villages of Awala-Yalimapo (0.4%) and Trois-Sauts (0.9%) than in Trois-Palétuviers (3.2%), Talhuen (3.6%), and Camopi (3.9%), where it was close to 4% (Figure 1b). The number of cases diagnosed in each of these settlements and the respective prevalence are detailed in Table 2.

In terms of disease knowledge, 89 participants (54.3%) were unable to name any of the potential modes of transmission for scabies. However, this proportion varied between communities (90% for Maroons, 35.9% for Amerindians). Concerning socio-economic variables, 24% of patients had no health insurance, 31.7% only had primary education or no school education at all. 71 patients (43.3%) lived in a carbet (traditional house with a palm roof and no walls), and 17 in an informal settlement (10.4%). In terms of disinfection, 59 (35.9%) had access to a washing machine; 37 (22.6%) had neither electricity nor running water in their homes (see Data S2).

Data at Week 6

The characteristics of the 93 participants seen again at W6 are detailed in Data S3. Treatment failure was

TABLE 1 Clinical and socio-demographic characteristics at inclusion; GUYAGALE study, Guiana, 2021 ($n = 164$).

Characteristic	Number of participants	%
Age		
< year	11	6.7
1–4 years	42	25.6
5–14 years	32	19.5
15–24 years	31	18.9
25–50 years	35	21.3
>50 years	7	4.3
Missing data	6	3.7
Gender		
Male	83	50.6
Female	81	49.4
Mother tongue		
Amerindian language	64	39.0
Creole	57	34.8
Maroon dialect	20	12.2
French	16	9.8
Spanish	3	1.8
Portuguese	2	1.2
English	1	0.6
Chinese	1	0.6
Nationality		
French	110	67.1
Haitian	34	20.7
Surinamese	11	6.7
Brazilian	5	3.1
Dominican Republic	3	1.8
Chinese	1	0.6
Pre-consultation treatments/care		
Corticosteroid creams	21	12.8
Plants	29	17.7
Shaman/traditional healer	0	0
Location of lesions		
Upper limbs	126	76.8
Lower limbs	86	52.4
Trunk	110	67.1
Head and neck	17	10.4
Genitalia	31	18.9
Lesion type		
Vesicles	140	85.4
Papules	85	51.8
Burrows	11	6.7
Nodules	14	8.5
Presence of impetigo		
Yes	41	25.0
No	123	75.0
Thinks the disease is caused by[a]		
Clothing	40	24.4
Bed sharing/hammock	35	21.3
Skin contact	15	9.2
Lack of hygiene	5	3.1
Sexual intercourse	0	0
No answer	89	54.3
Level of education		
Primary or below	52	31.7
Secondary	77	46.9
Baccalaureate and above	29	17.7
Missing data	6	3.7
Health insurance		
Yes	118	71.9
No	39	23.8
Missing data	7	4.3
Salaried occupation for a family member		
No	95	57.9
Yes, including:	69	42.1
Employee/craftsman	44	26.8
White collar	25	15.2
Type of housing		
Modern house	68	41.5
Carbet[b]	71	43.3
Informal settlement	17	10.4
Missing data	8	4.9
Home appliance and equipment		
No equipment	37	22.6
Electricity	112	68.3
Running water	77	46.9
Washing machine (cold water)[c]	28	17.1
Washing machine (hot water)	59	35.9
Missing data	7	4.3
Clothing		
Traditional	19	11.6
Western	145	88.4

[a]Data collected from parents where the child was not old enough to speak. The question was asked without suggesting answers in the questionnaire. The bed/hammock item was added because it was spontaneously mentioned by participants. An answer given by a head of family was extended to all members.

[b]Traditional Amazonian wooden house with palm roof and no walls.

[c]Many people in the hinterland use washing machines which must be filled manually with cold water, therefore ineffective for scabies.

observed in 32 (34.4%), with persistence of impetigo in 11 cases (11.8%). Of note, failure was observed in 5 out of 6 patients of Surinamese nationality (83.3%), and 7 out of 8 patients (87.5%) treated topically with permethrin. We did not report any case of severe, diffuse or crusted scabies.

The univariable and multivariable analyses of factors associated with treatment failure at W6 are presented in Data S4 and Table 3, respectively. In the univariable analysis, disinfection of the bed/hammock

TABLE 2 Number of cases diagnosed and assumed minimum prevalence for five study sites, GUYAGALE, French Guiana, 2020–2021.

Study site	Number of cases diagnosed	Population (INSEE 2015)	Assumed miminum prevalence (%)
Awala-Yalimapo	6	1430	0.42
Trois-Sauts	7	800	0.88
Trois-Palétuviers	7	217	3.23
Talhuen	8	225	3.55
Camopi	47	1200	3.92

TABLE 3 Multivariable analysis of factors associated with scabies treatment failure; GUYAGALE study, French Guiana, 2021, ($n = 93$).

	Multivariable analysis[a]	
Variable	aOR [95% CI]	*p*-value
Clothing		
Traditional	1.68 [0.1–26.98]	0.71
Western	1	
Health insurance		
Yes	0.83 [0.12–5.68]	0.85
No	1	
Housing		
Modern house	0.15 [0.02–1.18]	0.072
Carbet or informal	1	
Treatment used		
Other	1	**0.001**
Permethrin	24.97 [6.12–1750.40]	
Second dose taken		
Yes	0.05 [0.01–0.37]	**0.004**
No	1	
Bed/hammock disinfection		
Yes	0.07 [0.01–2.01]	0.12
No	1	

[a]Variables with a *p*-value <0.2 in the univariate analysis were included in a stepwise regression to achieve a final multivariable model. Bold values indicate *p*-values < 0.05 in multivariate analysis

was associated significantly with a lower risk of treatment failure ($p = 0.025$), while an association with clothing disinfection was almost significant ($p = 0.056$). Wearing western clothes was also associated with a lower risk of failure, compared with the traditional clothes worn mostly by Amerindians ($p = 0.0001$). Other factors associated with a lower risk of failure included possession of French health insurance ($p = 0.0012$), adherence to the second treatment dose ($p = 0.0001$), and living in a 'modern' house as opposed to a carbet or informal housing ($p = 0.036$). The use of topical permethrin in monotherapy was associated with a higher risk of failure ($p = 0.0001$), a finding that was consistent in the multivariable analysis ($p = 0.001$). Taking a second dose of treatment (whatever the drug used) remained associated with a lower risk of therapeutic failure in the multivariable analysis ($p = 0.004$).

Qualitative study

21 participants were interviewed. The number of patients recruited to the qualitative component from each study site is presented in Figure 1c; the characteristics of the interviewees are presented in Data S5. Thematic categories and sub-categories for which saturation was reached through qualitative analysis are presented in Table 4, along with the corresponding communities for which each theme was observed.

When asked about the history of scabies in their communities, the participants reported various conceptions. Most Amerindians described the disease as having been recently introduced into their communities, a few decades earlier. The Palikur were the only Amerindian community to describe a long, consistent presence of the disease. This history was reflected in both the vernacular name for scabies and the local pharmacopoeia. The Palikur were the only community that had an ancient term (*wẽ*) to designate scabies. The other Amerindian communities used neologisms; scabies was known as *sikusin* (little white jigger) among the Wayãpi, and *koumishi* (itchy pimple) among the Kali'na. No specific pharmacopoeia was found for scabies among Amerindians other than the Palikur and the Maroons, where remedies known for their general dermatological effect were used. Examples of plants used for skin disorders include Madagascar periwinkle (*Catharanthus roseus*), Mexican sunflower (*Tithonia diversifolia*), crabwood (*Carapa guianensis*), bitter ash (Quassia amara) and ringworm shrub (*Senna alata*). Most plants were used topically, notably as a *washi*—a traditional Amazonian bath of cold water and leaves. The efficacy of the plants was frequently attributed to their bitterness. Lemon, vinaigrette and bicarbonate were reported among Haitian participants and used for their caustic power.

> We don't have any plants for that, just carapa oil. Then for the puce-chiques (tungiasis) you can take the nest of the yellow-tailed cacique, you burn it and scatter the ashes around the carbet, or you take the bitter cassava juice. But it doesn't work for scabies.
>
> 47-year-old man, Camopi (Teko)

TABLE 4 Categories and sub-categories[a] identified among participants to the qualitative analysis, with the corresponding community; GUYAGALE study, French Guiana, 2021.

Category	Sub-category	Corresponding community
History of scabies in the community	*Scabies is an ancient disease that has always existed here*	Palikur Amerindian
	Scabies is a new disease in the community	Others
Traditional medicine	*Traditional medicine is used to treat scabies*	All communities
	Specific plants are used to treat scabies	Palikur Amerindian
	Non-specific plants are used both for scabies and other skin disorders	Others
Causes of scabies	*Scabies is infectious and can partially be removed by hand*	Amerindian
	Scabies is infectious but voodoo can cause the infection	Haitian
	Scabies is an infestation caused by insects	Ndjuka Maroon
Environmental disinfection	*Disinfection is complex due to the lack of amenities*	All communities
	Acaricides are useful but expensive	All communities
Adherence to treatment	*Topical treatments work better*	All communities
Stigmatization	*Scabies is associated with high social stigma*	Amerindian, Haitian
	Scabies is a common event without significant stigma	Ndjuka Maroon

[a]Categories and sub-categories were determined when data saturation was reached (when interviews produced the same repeatedly). Non-saturated data are not included in these categories.

The infectious nature of the disease was widely known, especially among Amerindians, with participants reporting the ability of some matrons to see the adult parasites and extract them with a needle. Magical causes were never mentioned by Amerindians or Maroons. Unlike other skin diseases such as *pityriasis alba*, the appearance of scabies was not linked to any violation of taboos or ritual prohibitions.

> A: That's not scabies (referring to white patches of *pityriasis alba* on his daughter's skin). I have a son who also has this eczema. When he was a baby, I disobeyed the ancestors, I went hunting. You shouldn't kill the paca (*Cuniculus paca*), you shouldn't kill animals that have youngsters. As the paca has white spots, my son now has white spots.
>
> I: What about scabies? Does it happen when you disobey too?
>
> A: No, it's different, it's the hammock when you don't wash, it's full of dust, little bugs that come and get under the skin.
>
> 37-year-old man, Camopi (Teko)

Scabies was declared by Amerindians and Maroons to be outside the remit of shamans. By contrast, magical causes were only partially ruled out by Haitians; several patients reported the theoretical possibility of a voodoo cause, but felt they did not have an enemy fierce enough to resort to it and concluded that their illness could not be linked to magic.

> In fact, my mother had a revelation, she told me that it's actually mystical things […] she called me to tell me that someone is after me, he put something in my house, but […] as I came here, I was prescribed medication, and it went away. I don't believe it […] how could anyone be so angry at me to do that? I don't know, God only knows.
>
> 38-year-old-man, Cayenne (Haitian)

Various misconceptions were reported, attributing scabies to contact with water, animals (dogs, chickens), blood contamination or poor personal hygiene. The source of infection was often reported as originating from outside the community. For example, many Amerindian families reported infections occurring when children came back from boarding school with scabies during the summer holidays. Environmental disinfection was described as complex, for various reasons, as hammocks and clothing could not be dried after washing during the rainy season. Patients often had to boil their clothes in cooking pots. Pyrethroid acaricides were viewed favourably as effective and easy to use, but their cost was highlighted.

> I: Do you think people have a problem buying A-PAR?
>
> A: Sometimes yes, for them the priority is to eat, 15 euros is the equivalent of a 25 kg bag of rice.
>
> 30-year-old woman, Maripasoula (Aluku)

Western remedies were generally considered to be effective, though it did not prevent participants from using traditional

plants as well. Topical Western treatments were often rated favourably due to the burning sensation, which patients associated with greater efficacy, as opposed to oral treatments.

> I think that Ascabiol will work better, because when we had aches and pains as children, we used methylated spirits. The elders used Ascabiol and when it hurt we felt that it was working.
>
> 30-year-old woman, Maripasoula (Aluku)

A high level of stigmatization was found in all communities, with the notable exception of the Ndjuka. Among Amerindians, rejection because of scabies was due to the visible pruritus and fear of contagion, and resulted in exclusion from social gatherings.

> If a family has scabies, they can come to the caichiri, but they stay in their corner, they share the same calabash. Because of the children, afterwards they get infected.
>
> 28-year-old man, Trois-Sauts, (Wayãpi)

Among the Ndjuka, scabies was attributed to seasonal insects and was so common that it became a normal, non-stigmatizing event, thus reducing the need for treatment.

> A: For people, they're bugs that come and go when they want […] they don't really feel the need to get a treatment […] for them, it comes with the season.
>
> 23-year-old woman, Javouhey (Ndjuka)

DISCUSSION

The primary aim of the study was to identify specific factors associated with the failure of treatment for scabies. The proportion of failure was 34.6%, higher than in two previous studies conducted in mainland France (26.3% and 25%).[23,25] In multivariable analysis, as in one of the studies in mainland France and in a recent Italian report,[23,26] adherence to the second dose was associated with therapeutic success.

Possession of health insurance was also associated with a lower risk of failure in the univariable analysis, as described previously in metropolitan French territory. Patients without insurance have to pay for their own treatment or ask for free treatment at a health centre. As drugs are often in short supply at these dispensaries, this often results in treatment being delayed.

Permethrin in monotherapy was associated with a higher risk of therapeutic failure, though this result is based on a small number of patients and should be viewed with caution. Permethrin cream has been associated with poor adherence in Aboriginal Australians due to a lack of private rooms for applying the cream, and bathroom facilities for washing.[7] However, in this study, participants seemed willing to accept topical treatments, as found in the qualitative analysis. Local side effects might also be a factor of poor adherence to common acaricides. Nevertheless, robust data are required to further evaluate the efficacy of permethrin cream in real-life conditions.

One hypothesis for this study was that 'magical' explanations for scabies could lead to poor adherence to treatment. However, no magical cause was attributed to scabies by any Amerindian or Maroon participants. Although skin diseases such as *pityriasis alba* were linked to breaches of mythical prohibition, as reported for other diseases in French Guiana,[27] scabies clearly seemed beyond the remit of shamans and traditional healers.

In contrast, there appeared to be a magical interpretation among Haitian participants. In the literature, magical causes are rarely attributed to scabies, and only reported in West Africa.[5,28] West Africa is the geographical area from which slaves were transported to Haiti, and the links between Haitian voodoo and West African magical traditions are well established.[29]

Another factor linked to treatment adherence was the choice of galenic formulation. The qualitative interviews showed that Amerindians and Maroons tended to prefer topical formulations such as benzoate benzyl lotion and permethrin cream. The burning sensation associated with local benzoate benzyl was possibly a placebo effect. In addition, the lotion formulation is closer to traditional medicines such as leaf baths (washi). In the Maroon conception of disease, the skin is thought to convey the effects of topical remedies like washi throughout the whole body, while oral treatments only cure the digestive system.[30] Scabies was mainly treated using traditional medicinal plants by the participants in this study, including plants previously reported in the Amerindian pharmacopoeia of French Guiana.[31] Overall, these data suggest the efficacy of doctor–patient discussion to outline the various galenic options.

In terms of knowledge of the disease, the fact of scabies being caused by an infection was particularly obvious for Amerindian participants, as they were able to see and remove the adult parasite manually. This exceptional visual acuity has also been reported in the Colombian Amazon.[11] Despite the notion of an infectious mechanism, knowledge of the transmission modes appeared to be very poor; comparable to the figures found in Pakistan[32] and lower than those reported in Guinea-Bissau[5] and Indonesia.[33] In this study, knowledge was found to be particularly poor among Maroons (90% could not name any mode of transmission) compared to Amerindians (36%). Transmission via hammocks or clothing was the most widely known way of contracting scabies, in line with the results observed in the qualitative study.

Stigmatization due to scabies varied between communities, reflecting the different levels of stigma reported in the literature. For example, in Brazil there was greater stigma attached to scabies in an outpatient department in Recife[34] than in a slum in Fortaleza,[35] possibly due to the lower prevalence of the disease and higher standard of living in Recife.

In this study, there was a low level of stigmatization associated with scabies among the Ndjuka, who saw it as a frequent, normal event. Similarly, scabies has been described as a rite of passage to adulthood among the Santri community in Indonesia, with prevalence approaching 100%.[33] A similar phenomenon of acceptance of the disease is found among Australian Aborigines.[7]

The need for environmental disinfection was described as a real barrier to treatment adherence in all the communities in the study. This is consistent with the quantitative data in terms of poor access to household appliances, and there is a significant correlation between therapeutic failure and the absence of bed/hammock disinfection in the univariable analysis. It is possible that owning Western clothes or having health insurance might be confounding factors linked to socio-economic status. However, it is noteworthy that disinfection of sleeping fabrics was associated to treatment outcome, whether the patient slept in a real bed with mattress or in a hammock, suggesting that disinfection might have played a role, whatever the socio-economic status.

The importance of fomite disinfection for the treatment of scabies is under debate. Direct skin contact is often seen as the first cause of contamination,[36] but it is known from an outbreak among hospital laundry workers that scales shed onto bedding can transmit scabies.[37] It has also been shown in cross-sectional surveys of homeless French people that owning a sleeping bag and not sharing it with other individuals is a protective mechanism against scabies, suggesting the role of fomites in transmission.[38] Although the decontamination of fomites might not be a feasible or effective strategy at a population level, it remains part of the recommended treatment on an individual level.[39,22]

Environmental disinfection can be challenging in low-resources settings. Following requests for advice on disinfection from indigenous Australian communities, Bernigaud et al. showed in 2020 that a temperature of 50°C or higher maintained for at least 10 minutes was required to kill the mites.[39] However, the only option for patients with limited access to washing machines was to isolate the fomites, which is problematic for them, particularly in hot, rainy, humid areas such as French Guiana where an isolation period of up to 8 days is needed.[39]

In these conditions, the simplest solution could be to spray the fomites with acaricides. Participants mentioned these products favourably during the interviews, but their high cost was pointed out. Making acaricides freely available from local health centres could therefore represent a cost-effective option as it would circumvent many therapeutic failures and eliminate the expense of further treatment.

This study has several potential strengths and weaknesses. There is no strong recommendation for the time before the second visit in scabies follow-up, which can vary between 2 weeks and 3 months[23,22] We chose a 6-week compromise which seemed appropriate for this observational real-life study designed to analyse various factors associated with therapeutic failure. Some communities were represented by only a few participants in the qualitative component, which may have biased some of the interpretations. As this was a pilot study, a convenience sample was used and more complex methods such as snowball sampling were not used. Future qualitative studies could use a more elaborate sampling technique. Intervention by traditional healers might have been underestimated, as individuals who only use traditional medicine were not included.

In quantitative terms, the number of individuals lost to follow-up was significant and resulted in a decrease of the study statistical power to 65% when searching for factors associated with treatment failure, using the same assumption regarding the prevalence of exposure in the control group. Many patients probably did not understand the importance of the follow-up consultation or could not afford the travel cost for a second visit. Difficulties in phone communications across the borders of French Guiana prevented us reminding patients who lived along the rivers of their follow-up consultations. In addition, the Oyapock River flooded during the study period, causing another major loss to follow-up.[40] This loss of follow-up is an important result and represents a potential target for an interventional study. It also raises the question of follow-up methods that would be more appropriate for remote settings, including teledermatology. This loss of follow-up also underlines the need for a more thorough integration of community health workers in the French health system. A recent governmental decree paved the way for the future development of a medical profession which is still not fully recognized in the French system.[41]

The hypothesis for this study was that the high failure rate for the treatment of scabies in French Guiana is related to social and cultural components. However, variables linked to socio-demographic components (clothing, disinfection, housing) were significantly associated with treatment failure only in the univariable analysis. Their interpretation therefore remains complex. The type of clothing and housing (traditional or modern), as well as having health insurance, might not be real risk factors for treatment failure but rather indicators of social hardship and geographic isolation, and consequently barriers to health care access.

Translational studies could explore the survival of eggs and mites in fomites in autochthonous communities to help understand the role of beddings and clothes in treatment failure. Most of the drugs used to treat scabies are not ovicidal and only kill adult mites, but drugs such as moxidectin that have a longer half-life on the skin could reduce the level of treatment failure.[42]

One of the strengths of this study is the rare combination of quantitative and qualitative results on knowledge, attitudes and practices (KAP) in scabies and implications for the outcomes of treatments. The multicultural diversity of French Guiana meant that participants from very different communities could be included in the same study. A high proportion of them were living in remote areas rarely investigated due to logistical difficulties. Control strategies should be adapted to local circumstances in terms of

galenic formulations and means of environmental disinfection. Public health initiatives should use different strategies according to the level of stigma encountered in each community. Specific findings in French Guiana may not apply to other countries or populations, so similar local studies should be carried out in different communities of endemic countries.

AUTHOR CONTRIBUTIONS

PC, AD and MN coordinated the study. OC, RB, AD, PC and MN conceived the study. RB and AD did the initial literature search. AA provided assistance for statistical analysis. RB handled the inclusions and follow-up visits, carried out the statistical analysis and drafted the paper. CP, OD, FN and CB identified the participants. FA and RB conceived the qualitative component and carried out the semi-structured interviews. CM provided assistance for the conception, logistics and inclusion of participants. All authors had full access to all the data in the study and final responsibility for the decision to submit for publication.

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CONFLICT OF INTEREST STATEMENT

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in the supplementary material of this article.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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